

Construction of Concrete Shoulders

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INTRODUCTION

Illinois has constructed concrete shoulders on portions of three contracts. During the 1963-1964 construction season, our contracts permitted the contractor the option of the type of stabilizing agent to use with a gravel or crushed stone material to produce a stabilized shoulder.

We had progressed to this high type shoulder as have most highway departments in order to try to reduce maintenance problems, eliminate drop-offs at pavement edges, and provide a year-round safe recovery and emergency stopping areas. We have on the Illinois highway system earth shoulders, gravel shoulders, crushed stone shoulders, cement aggregate mixtures (or CAM) shoulders, bituminous aggregate mixtures (or BAM) shoulders, and pozzolanic mixtures (or PAM) shoulders. None of these shoulders have proven to be trouble-free.

FIRST CONCRETE SHOULDERS IN ILLINOIS—1965

In the spring of 1965, a contractor requested the division of highways to consider a proposal to place Portland cement concrete shoulders in place of the options provided in the contract. After consideration by the division, it was decided to permit this change in plans. We hoped to determine the extent of any construction problems and by observation, in future years, to see what maintenance problems might develop. This first construction of Portland cement concrete shoulders is located just north of East Peoria on U.S. 150 between Interstate 74 and Illinois 87. The project is approximately five miles long.

The roadway begins at the urban limits of East Peoria and varies from a 4-foot concrete median to a 40-foot depressed median as it leaves the urban area. The northbound lanes were an existing concrete pavement which had been resurfaced several years before and were to be resurfaced with a bituminous hot mix again on this contract. The new southbound lanes were to be constructed of conventional 10-inch Portland cement concrete pavement with 100-foot contraction joints.

General Dimensions of Unreinforced Shoulders

The proposed concrete shoulder was to be constructed 6 inches thick and 8 feet wide on the outside shoulders. Where there was a depressed median, a 4-foot wide median shoulder was constructed. The whole shoulder is *unreinforced* with edged dummy joints opposite the contraction joints. We were concerned that people might consider this an additional lane and therefore required that a transverse rumble strip be finished in the surface of the pavement at prescribed intervals.

Shoulder Tie Methods

Four methods were used to tie and/or key the shoulder into the main line pavement. First, the Portland cement concrete shoulder was placed next to the resurfaced pavement with no tie bars. Second, where the adjacent Portland cement concrete roadway was partially constructed, we required holes to be drilled into the pavement and 18-inch tie bars were grouted into the pavement. Third, on Portland cement concrete pavement to be constructed, 18-inch tie bars were placed at 3-foot centers during the paving operation. Fourth, a recessed keyway was constructed in the pavement with no tie bars.

Concrete Placement, Curing and Finishing

The contractor placed the plastic concrete by use of a slipform paver made in his own shop. The paver was nothing more than a spreader box on skids and weighted to keep the box on the earth grade. A motor patrol was used to hold the box against the edge of the existing pavement. A rubber-tired dozer was used to provide the propulsion for the box.

The concrete was mixed in the central mix plant set up for mixing the main-line paving. The concrete was delivered to the slipform unit by agitator dump trucks. Vibration was furnished by three internal vibrators. An edge plate was used to provide a finished edge. A burlap drag was attached to the end of the paver to provide a surface texture, and the only hand finishing usually required was the forming of the rumble strip.

The rumble strip was formed by use of a flattened piece of corrugated metal plate every 50 feet. The edge of the slipformed concrete was held in place by a board while the rumble strip was finished by several passes with the corrugated plate.

Curing compound was applied by use of a machine which is usually used on Portland cement concrete widening.

The contractor used a shop-made, tractor-mounted jackhammer which drilled the holes for grouting in the dowel bars.

The whole operation was relatively trouble-free. I have had occasion to visit this job this past March (1971) and after six years, the shoulders appear to be just as constructed with no signs of any maintenance problems to date.

SECOND CONCRETE SHOULDERS PROJECT—1966

During the winter of 1965-1966, the division of highways was again asked for permission to place Portland cement concrete shoulders by a different contractor. This project was on I-74 east of Morton, Illinois. In this case, the shoulders were to be placed adjacent to continuously reinforced Portland cement concrete pavement. Since the transverse cracking pattern on continuously reinforced Portland cement concrete pavement is about 3 feet to 12 feet, we were interested as to how Portland cement concrete shoulders with no reinforcing would perform. At the same time, Illinois was considering the use of an open-graded aggregate subbase under out shoulders, and we decided to include this variable in the field demonstration.

Unreinforced Shoulders on Various Subbases

We placed 6 in. thick Portland cement concrete shoulders without reinforcement adjacent to a 24-foot wide, 7-inch thick, continuously reinforced Portland cement concrete pavement. The outside shoulder was constructed 10 feet wide and the median shoulder was 4 feet wide. The Type A shoulder was placed on a 1-inch top-size aggregate subbase with a pipe underdrain to drain the subbase and was tied into the pavement with tie bars and keyway. This design was also constructed using a 1½-inch top-size aggregate subbase. The Type B shoulders were placed directly on a compacted earth subgrade and were tied directly to the continuously reinforced pavement with tie bars. The Type C shoulders were placed on a 1-inch top-size aggregate subbase which extended all the way out to the slope to act as a drain. This Type C shoulder was also constructed on a 1½-inch top-size aggregate subbase. The Type D shoulder was placed on a compacted earth grade with a keyway in the pavement but without tie bars.

This contractor used substantially the same equipment and methods as were used on the first concrete shoulder project. A different rumble strip with sharper and deeper corrugations was made and constructed at several different intervals. This strip is more noticeable to a driver and will alert him much quicker.

EXPERIMENTAL DESIGNS 1967-1968

The division of highways has also constructed in 1967-1968 a research project with several different shoulder designs under certain necessary controls. The designs included BAM, CAM and PAM and Portland cement concrete shoulders. Various sections were built with and without open-graded subbase. They were constructed next to continuously reinforced 8-inch Portland cement concrete pavement.

Recent Observations

During this last March (1971), I visited these jobs and made the following observations:

1. Most desirable rumble strip spacing is 60 feet.
2. Snow plows can diminish effectiveness of rumble strips—they chip edges.
3. Shoulders crack on approximately 20-foot spacing.
4. No differential settlement between main line and shoulder section.
5. Traveling public does not consider this shoulder to be a driving lane.

A cost study in Illinois has indicated that the concrete shoulder compares economically justifiable at this time with other types. It is approximately seven percent higher than their BAM shoulders, but is less expensive than the CAM shoulders. The conclusion reached was that all the concrete shoulders placed are performing satisfactory with no signs of any maintenance requirement to date.